

# PCF8575 割り込み出力付き、リモート 16 ビット、I<sup>2</sup>C および SMBus I/O エクスパンダ

## 1 特長

- I<sup>2</sup>C からパラレルポートへのエクスパンダ
- オープンドレイン割り込み出力
- 低いスタンバイ消費電流: 10 $\mu$ A 以下
- ほとんどのマイクロコントローラと互換
- 400kHz の Fast I<sup>2</sup>C バス
- 3 本のハードウェアアドレスピンにより、8 つまでのデバイスをアドレス指定可能
- 大電流の駆動能力を持つラッチ付き出力により、LED を直接駆動
- V<sub>CC</sub> への電流ソースにより出力をアクティブに High に駆動
- JESD 78、Class II 準拠で 100mA 超のラッチアップ性能
- JESD 22 を超える ESD 保護
  - 人体モデルで 2000V
  - マシンモデルで 200V
  - 荷電デバイスモデルで 1000V

## 2 アプリケーション

- テレコム シェルター: フィルタ ユニット
- サーバー
- ルーター (テレコム スイッチング機器)
- [パーソナルコンピュータ](#)
- [パーソナルエレクトロニクス](#)
- [産業用オートメーション](#)
- 限定された GPIO を利用した製品

## 3 概要

この 2 線式双方向バス (I<sup>2</sup>C) 用 16 ビット I/O エクスパンダは、2.5V~5.5V の V<sub>CC</sub> で動作するように設計されています。

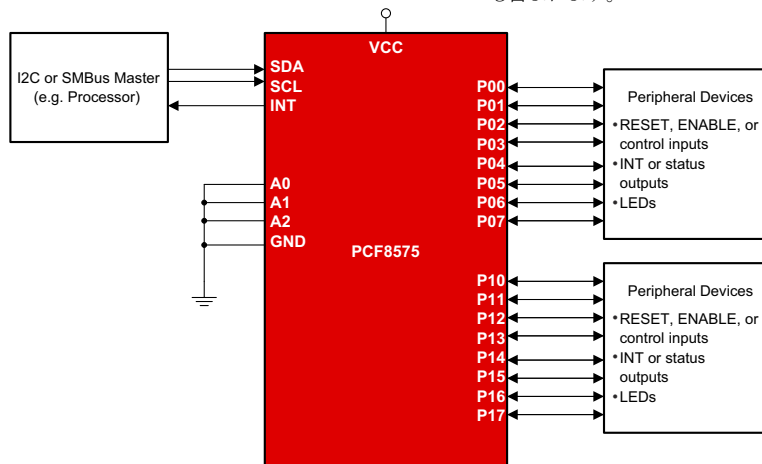
PCF8575 デバイスは、I<sup>2</sup>C インターフェイス [シリアルクロック (SCL)、シリアルデータ (SDA)] により、ほとんどのマイクロコントローラファミリの汎用リモート I/O 拡張に使用できます。

このデバイスには 16 ビット、疑似双方向の入力/出力 (I/O) ポート (P07~P00、P17~P10) があり、大電流駆動能力を持つラッチ付き出力により LED を直接駆動できます。それぞれの疑似双方向 I/O は、データ方向制御信号を使用せずに、入力または出力として使用できます。電源投入時、I/O は HIGH になります。このモードでは、V<sub>CC</sub> への電流源のみがアクティブになります。

### パッケージ情報

部品番号	パッケージ (1)	パッケージサイズ (2)
PCF8575	SSOP (DB, 24)	8.2mm × 7.8mm
	SSOP (DBQ) (24)	8.65mm × 6mm
	TVSOP (DGV) (24)	5mm × 6.4mm
	SOIC (DW, 24)	15.5mm × 10.3mm
	TSSOP (PW, 24)	7.8mm × 6.4mm
	VQFN (RGV, 24)	4mm × 4mm

- (1) 利用可能なパッケージについては、[セクション 12](#) を参照してください。
- (2) パッケージサイズ (長さ × 幅) は公称値であり、該当する場合はピンも含まれます。



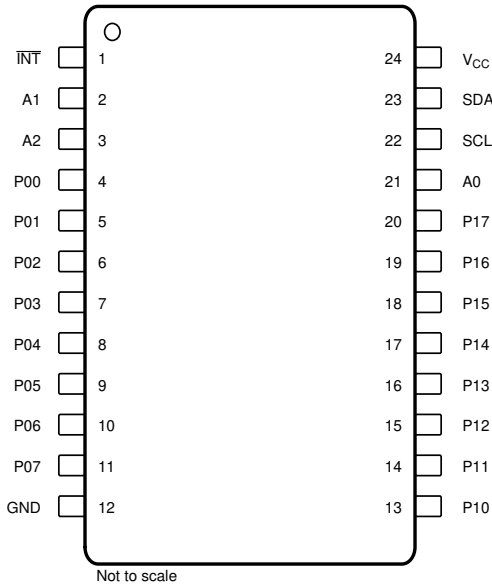
概略回路図



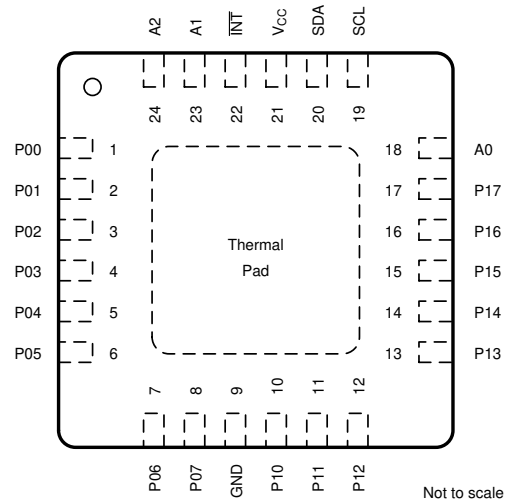
## Table of Contents

<b>1 特長</b> .....	1	8.4 Device Functional Modes.....	16
<b>2 アプリケーション</b> .....	1	<b>9 Application and Implementation</b> .....	18
<b>3 概要</b> .....	1	9.1 Application Information.....	18
<b>4 Pin Configuration and Functions</b> .....	3	9.2 Typical Application.....	18
<b>5 Specifications</b> .....	4	9.3 Power Supply Recommendations.....	20
5.1 Absolute Maximum Ratings.....	4	9.4 Layout.....	21
5.2 ESD Ratings.....	4	<b>10 Device and Documentation Support</b> .....	23
5.3 Recommended Operating Conditions.....	4	10.1 Device Support.....	23
5.4 Thermal Information.....	4	10.2 Documentation Support.....	23
5.5 Electrical Characteristics.....	5	10.3 ドキュメントの更新通知を受け取る方法.....	23
5.6 I <sup>2</sup> C Interface Timing Requirements.....	5	10.4 サポート・リソース.....	23
5.7 Switching Characteristics.....	6	10.5 Trademarks.....	23
<b>6 Typical Characteristics</b> .....	7	10.6 静電気放電に関する注意事項.....	23
<b>7 Parameter Measurement Information</b> .....	9	10.7 用語集.....	23
<b>8 Detailed Description</b> .....	12	<b>11 Revision History</b> .....	23
8.1 Overview.....	12	<b>12 Mechanical, Packaging, and Orderable Information</b> .....	23
8.2 Functional Block Diagram.....	13		
8.3 Feature Description.....	14		

## 4 Pin Configuration and Functions



4-1. DB, DBQ, DGV, DW, or PW Package SSOP, TVSOP, SOIC, TSSOP (Top View)



4-2. RGE Package VQFN (Top View)

NAME	PIN		TYPE	DESCRIPTION
	DB, DBQ, DGV, DW, AND PW	RGE		
A0	21	18	I	Address input 0. Connect directly to V <sub>CC</sub> or ground. Pull-up resistors are not needed.
A1	2	23	I	Address input 1. Connect directly to V <sub>CC</sub> or ground. Pull-up resistors are not needed.
A2	3	24	I	Address input 2. Connect directly to V <sub>CC</sub> or ground. Pull-up resistors are not needed.
INT	1	22	O	Interrupt output. Connect to V <sub>CC</sub> through a pull-up resistor.
P00	4	1	I/O	P-port input/output. Push-pull design structure.
P01	5	2	I/O	P-port input/output. Push-pull design structure.
P02	6	3	I/O	P-port input/output. Push-pull design structure.
P03	7	4	I/O	P-port input/output. Push-pull design structure.
P04	8	5	I/O	P-port input/output. Push-pull design structure.
P05	9	6	I/O	P-port input/output. Push-pull design structure.
P06	10	7	I/O	P-port input/output. Push-pull design structure.
P07	11	8	I/O	P-port input/output. Push-pull design structure.
GND	12	9	—	Ground
P10	13	10	I/O	P-port input/output. Push-pull design structure.
P11	14	11	I/O	P-port input/output. Push-pull design structure.
P12	15	12	I/O	P-port input/output. Push-pull design structure.
P13	16	13	I/O	P-port input/output. Push-pull design structure.
P14	17	14	I/O	P-port input/output. Push-pull design structure.
P15	18	15	I/O	P-port input/output. Push-pull design structure.
P16	19	16	I/O	P-port input/output. Push-pull design structure.
P17	20	17	I/O	P-port input/output. Push-pull design structure.
SCL	22	19	I	Serial clock line. Connect to V <sub>CC</sub> through a pull-up resistor
SDA	23	20	I/O	Serial data line. Connect to V <sub>CC</sub> through a pull-up resistor.
V <sub>CC</sub>	24	21	—	Supply voltage

## 5 Specifications

### 5.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted) <sup>(1)</sup>

		MIN	MAX	UNIT
V <sub>CC</sub>	Supply voltage range	-0.5	6.5	V
V <sub>I</sub>	Input voltage range <sup>(2)</sup>	-0.5	V <sub>CC</sub> + 0.5	V
V <sub>O</sub>	Output voltage range <sup>(2)</sup>	-0.5	V <sub>CC</sub> + 0.5	V
I <sub>IK</sub>	Input clamp current		-20	mA
I <sub>OK</sub>	Output clamp current		-20	mA
I <sub>OK</sub>	Input/output clamp current		-20	mA
I <sub>OL</sub>	Continuous output low current		50	mA
I <sub>OH</sub>	Continuous output high current		-4	mA
	Continuous current through V <sub>CC</sub> or GND		±100	mA
T <sub>stg</sub>	Storage temperature range		150	°C

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under [セクション 5.3](#) is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) The input negative-voltage and output voltage ratings may be exceeded if the input and output current ratings are observed.

### 5.2 ESD Ratings

		VALUE	UNIT
V <sub>(ESD)</sub>	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001, all pins	2000
		Charged device model (CDM), per JEDEC specification JESD22-C101, all pins	1000

### 5.3 Recommended Operating Conditions

		MIN	MAX	UNIT
V <sub>CC</sub>	Supply voltage	2.5	5.5	V
V <sub>IH</sub>	High-level input voltage	0.7 × V <sub>CC</sub>	V <sub>CC</sub> + 0.5	V
V <sub>IL</sub>	Low-level input voltage	-0.5	0.3 × V <sub>CC</sub>	V
I <sub>OH</sub>	P-port high-level output current		-1	mA
I <sub>OHT</sub>	P-port transient pullup current		-10	mA
I <sub>OL</sub>	P-port low-level output current		25	mA
T <sub>A</sub>	Operating free-air temperature	-40	85	°C

### 5.4 Thermal Information

THERMAL METRIC <sup>(1)</sup>	PCF8575							UNIT
	DB	DBQ	DGV	DW	PW	RGE		
	24 PINS							
R <sub>θJA</sub>	Junction-to-ambient thermal resistance	87.8	61	86	75.6	99.7	53.6	°C/W
R <sub>θJC(top)</sub>	Junction-to-case (top) thermal resistance	51.9			47.9	42.5	50.8	°C/W
R <sub>θJB</sub>	Junction-to-board thermal resistance	56.8			50.1	66.1	31.5	°C/W
Ψ <sub>JT</sub>	Junction-to-top characterization parameter	14.3			21.1	2.7	3.4	°C/W
Ψ <sub>JB</sub>	Junction-to-board characterization parameter	56.2			49.7	65.5	31.4	°C/W
R <sub>θJC(bot)</sub>	Junction-to-case (bottom) thermal resistance	-			-	-	14.8	°C/W

- (1) For more information about traditional and new thermal metrics, see the [Semiconductor and IC Package Thermal Metrics](#) application report.

## 5.5 Electrical Characteristics

over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS	V <sub>CC</sub>	MIN	TYP <sup>(1)</sup>	MAX	UNIT
V <sub>IK</sub>	Input diode clamp voltage	I <sub>I</sub> = -18 mA	2.5 V to 5.5 V	-1.2			V
V <sub>POR</sub>	Power-on reset voltage	V <sub>I</sub> = V <sub>CC</sub> or GND, I <sub>O</sub> = 0	V <sub>POR</sub>		1.2	1.8	V
I <sub>OH</sub>	P port	V <sub>O</sub> = GND	2.5 V to 5.5 V	-30		-300	μA
I <sub>OHT</sub>	P-port transient pullup current	High during ACK, V <sub>OH</sub> = GND	2.5 V	-0.5	-1		mA
I <sub>OL</sub>	SDA	V <sub>OL</sub> = 0.4 V	2.5 V to 5.5 V	3			mA
	P port	V <sub>OL</sub> = 0.4 V		5	15		
		V <sub>OL</sub> = 1 V		10	25		
	INT	V <sub>OL</sub> = 0.4 V		1.6			
I <sub>I</sub>	SCL, SDA	V <sub>I</sub> = V <sub>CC</sub> or GND	2.5 V to 5.5 V			±5	μA
	A0, A1, A2					±1	
I <sub>IHL</sub>	P port	-250mV < V <sub>i</sub> < GND	2.5 V to 5.5 V			±400	μA
I <sub>CC</sub>	Operating mode	V <sub>I</sub> = V <sub>CC</sub> or GND, I <sub>O</sub> = 0, f <sub>scl</sub> = 400 kHz	5.5 V		100	200	μA
			3.6 V		30	75	
			2.7 V		20	50	
	Standby mode	V <sub>I</sub> = V <sub>CC</sub> or GND, I <sub>O</sub> = 0, f <sub>scl</sub> = 0 kHz	5.5 V		2.5	10	
			3.6 V		2.5	10	
			2.7 V		2.5	10	
ΔI <sub>CC</sub>	Supply current increase	One input at V <sub>CC</sub> - 0.6 V, Other inputs at V <sub>CC</sub> or GND	2.5 V to 5.5 V			200	μA
C <sub>I</sub>	SCL	V <sub>I</sub> = V <sub>CC</sub> or GND	2.5 V to 5.5 V		3	7	pF
C <sub>io</sub>	SDA	V <sub>IO</sub> = V <sub>CC</sub> or GND	2.5 V to 5.5 V		3	7	pF
	P port				4	10	

(1) All typical values are at nominal supply voltage (2.5-V, 3.3-V, or 5-V V<sub>CC</sub>) and T<sub>A</sub> = 25°C.

## 5.6 I<sup>2</sup>C Interface Timing Requirements

over recommended operating free-air temperature range (unless otherwise noted) (see Figure 6-1)

			MIN	MAX	UNIT
f <sub>scl</sub>	I <sup>2</sup> C clock frequency			400	kHz
t <sub>sch</sub>	I <sup>2</sup> C clock high time		0.6		μs
t <sub>scl</sub>	I <sup>2</sup> C clock low time		1.3		μs
t <sub>sp</sub>	I <sup>2</sup> C spike time			50	ns
t <sub>sds</sub>	I <sup>2</sup> C serial data setup time		100		ns
t <sub>sdh</sub>	I <sup>2</sup> C serial data hold time		0		ns
t <sub>icr</sub>	I <sup>2</sup> C input rise time		20 + 0.1C <sub>b</sub> <sup>(1)</sup>	300	ns
t <sub>icf</sub>	I <sup>2</sup> C input fall time		20 + 0.1C <sub>b</sub> <sup>(1)</sup>	300	ns
t <sub>ocf</sub>	I <sup>2</sup> C output fall time	10-pF to 400-pF bus		300	ns
t <sub>buf</sub>	I <sup>2</sup> C bus free time between Stop and Start		1.3		μs
t <sub>sts</sub>	I <sup>2</sup> C start or repeated Start condition setup		0.6		μs
t <sub>sth</sub>	I <sup>2</sup> C start or repeated Start condition hold		0.6		μs
t <sub>sps</sub>	I <sup>2</sup> C Stop condition setup		0.6		μs
t <sub>vd</sub>	Valid-data time	SCL low to SDA output valid		1.2	μs
C <sub>b</sub>	I <sup>2</sup> C bus capacitive load			400	pF

(1) C<sub>b</sub> = total bus capacitance of one bus line in pF

## 5.7 Switching Characteristics

over recommended operating free-air temperature range,  $C_L \leq 100$  pF (unless otherwise noted) (see Figure 6-2 and Figure 6-3)

PARAMETER		FROM (INPUT)	TO (OUTPUT)	MIN	MAX	UNIT
$t_{iv}$	Interrupt valid time	P port	INT		4	$\mu$ s
$t_{ir}$	Interrupt reset delay time	SCL	INT		4	$\mu$ s
$t_{pv}$	Output data valid	SCL	P port		4	$\mu$ s
$t_{su}$	Input data setup time	P port	SCL	0		$\mu$ s
$t_h$	Input data hold time	P port	SCL	4		$\mu$ s

## 6 Typical Characteristics

$T_A = 25^\circ\text{C}$  (unless otherwise noted)

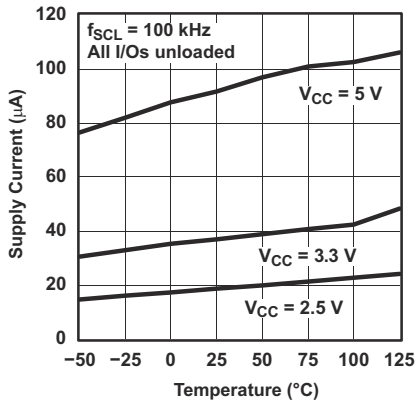


Figure 6-1. Supply Current vs Temperature

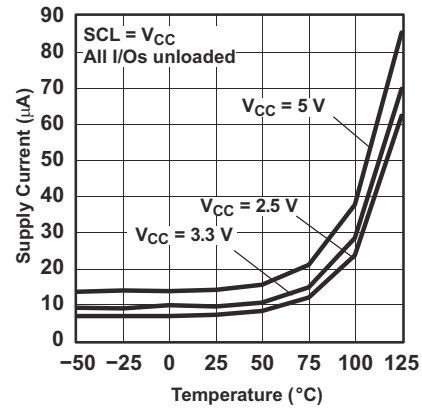


Figure 6-2. Standby Supply Current vs Temperature

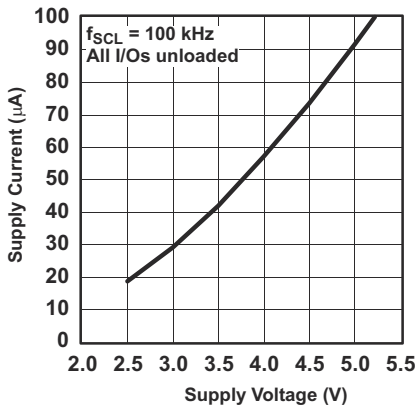


Figure 6-3. Supply Current vs Supply Voltage

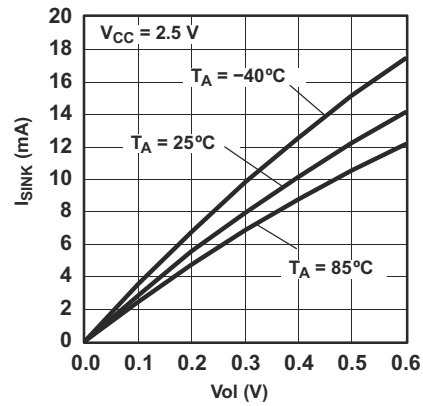


Figure 6-4. I/O Sink Current vs Output Low Voltage

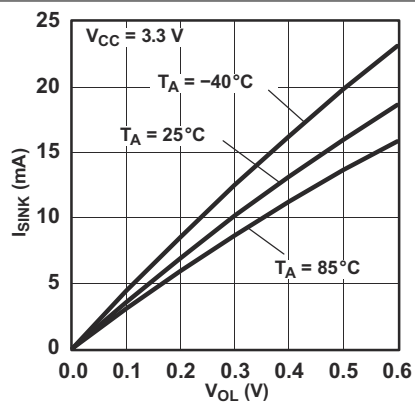


Figure 6-5. I/O Sink Current vs Output Low Voltage

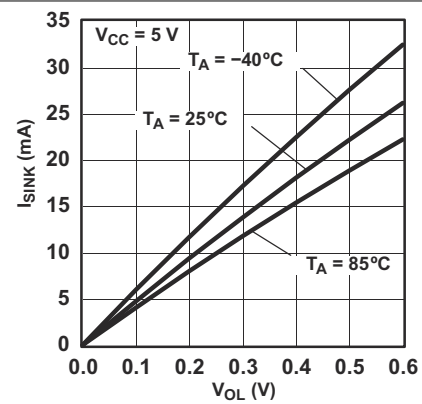


Figure 6-6. I/O Sink Current vs Output Low Voltage

## 6 Typical Characteristics (continued)

$T_A = 25^\circ\text{C}$  (unless otherwise noted)

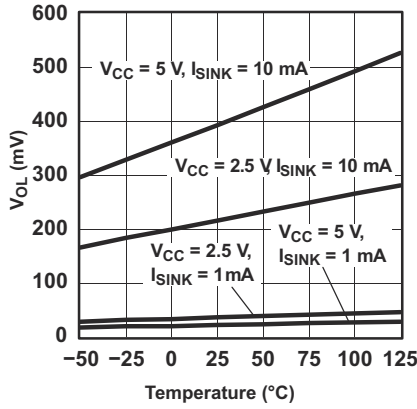


图 6-7. I/O Output Low Voltage vs Temperature

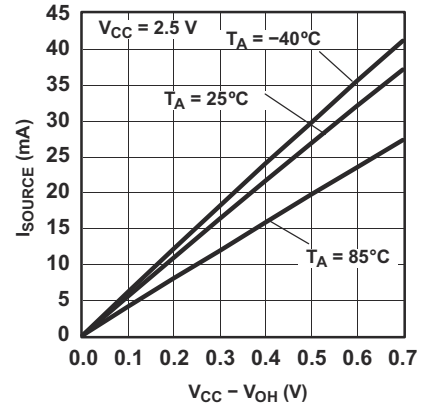


图 6-8. I/O Source Current vs Output High Voltage

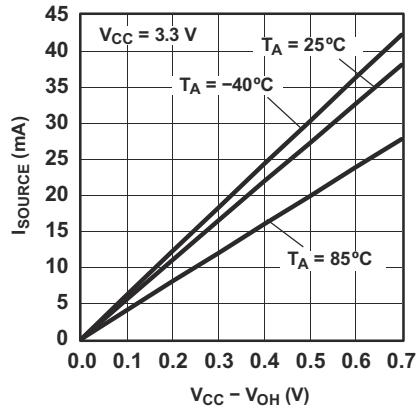


图 6-9. I/O Source Current vs Output High Voltage

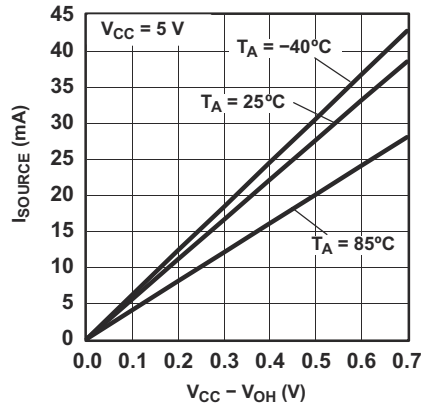


图 6-10. I/O Source Current vs Output High Voltage

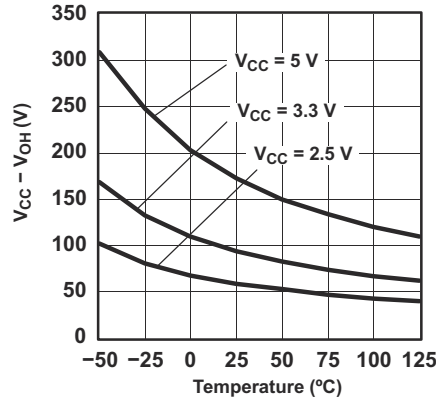
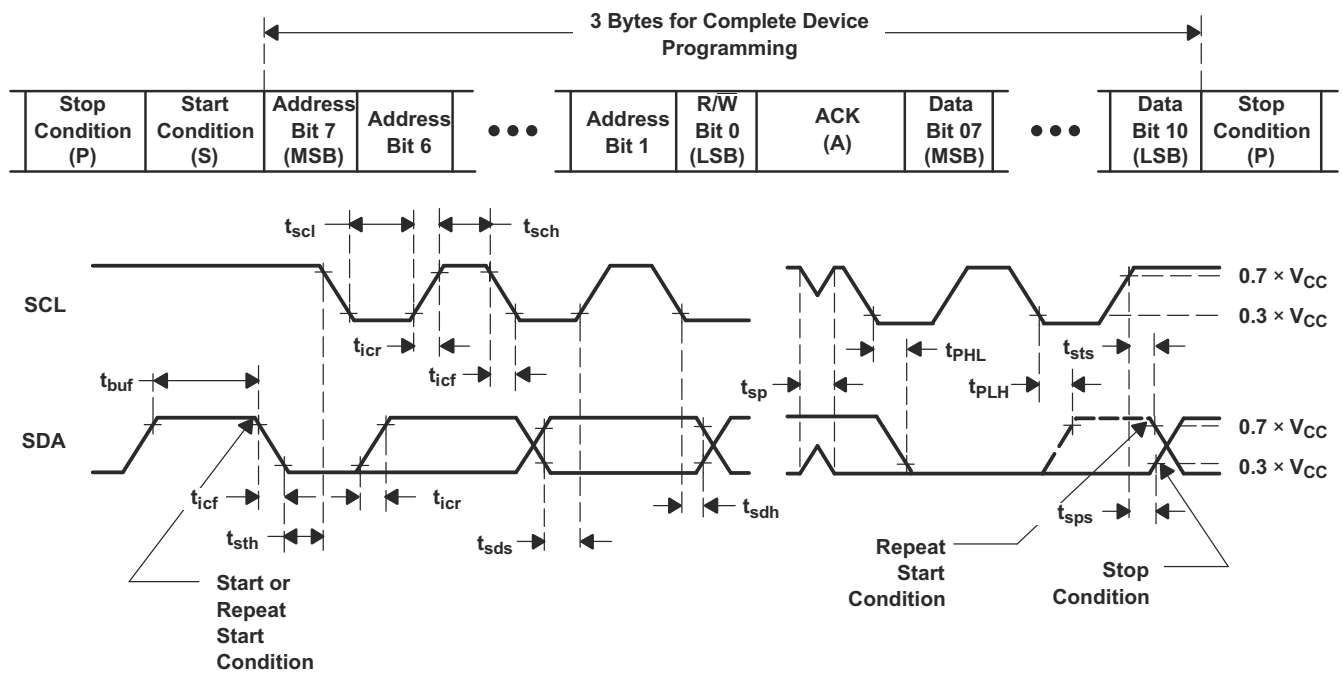
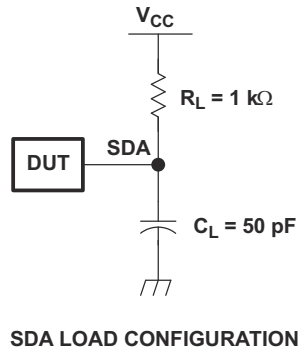


图 6-11. I/O High Voltage vs Temperature

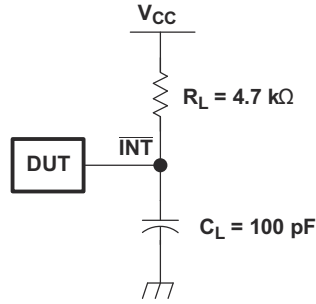


## 7 Parameter Measurement Information



BYTE	DESCRIPTION
1	I <sup>2</sup> C address
2, 3	P-port data

図 7-1. I<sup>2</sup>C Interface Load Circuit and Voltage Waveforms



INTERRUPT LOAD CONFIGURATION

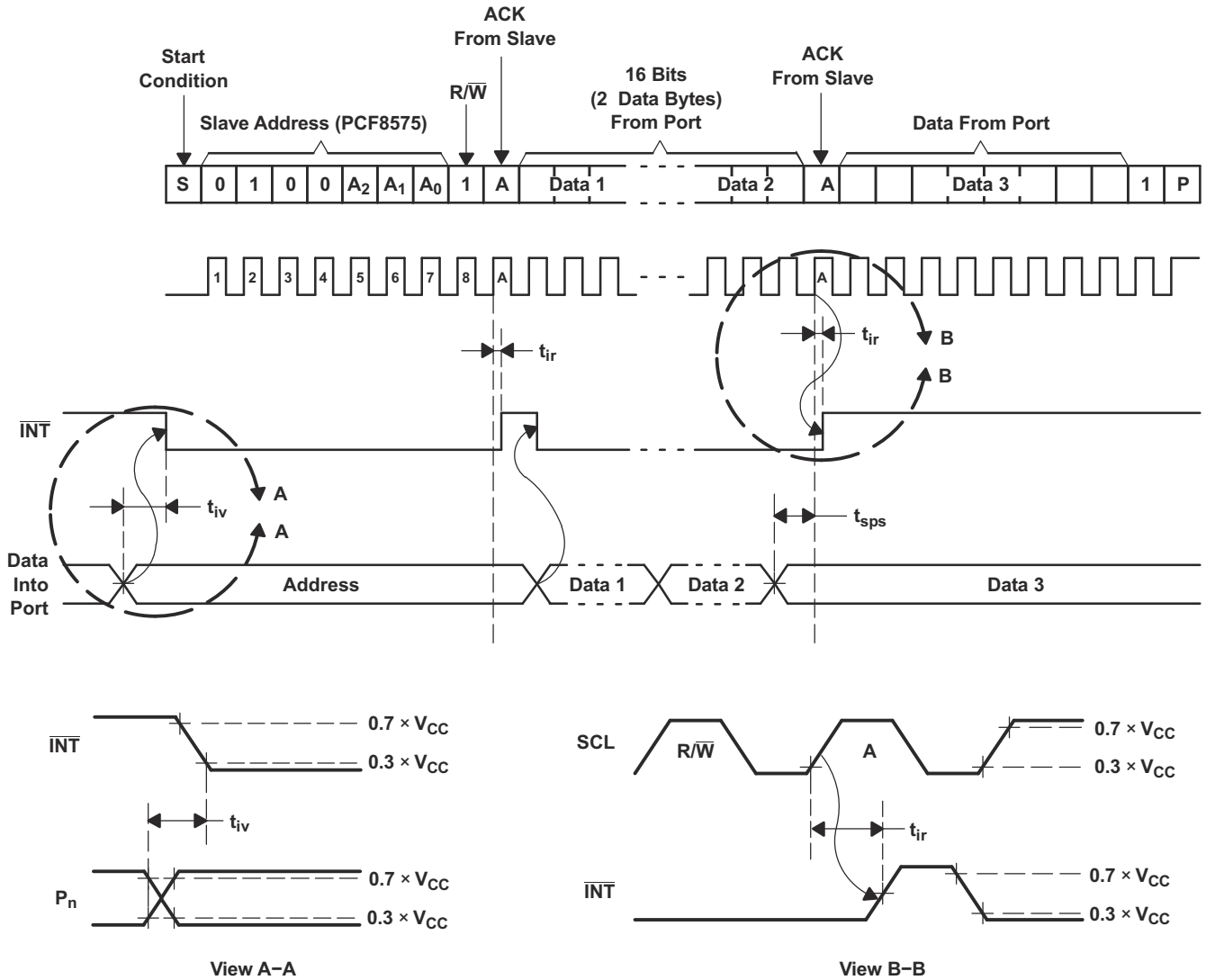
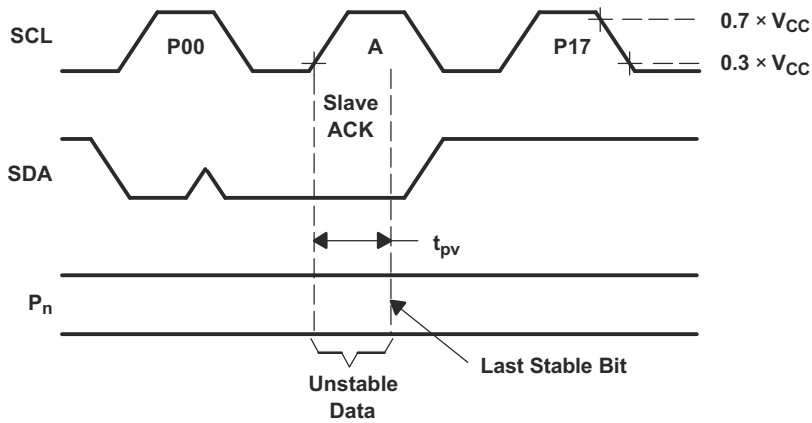
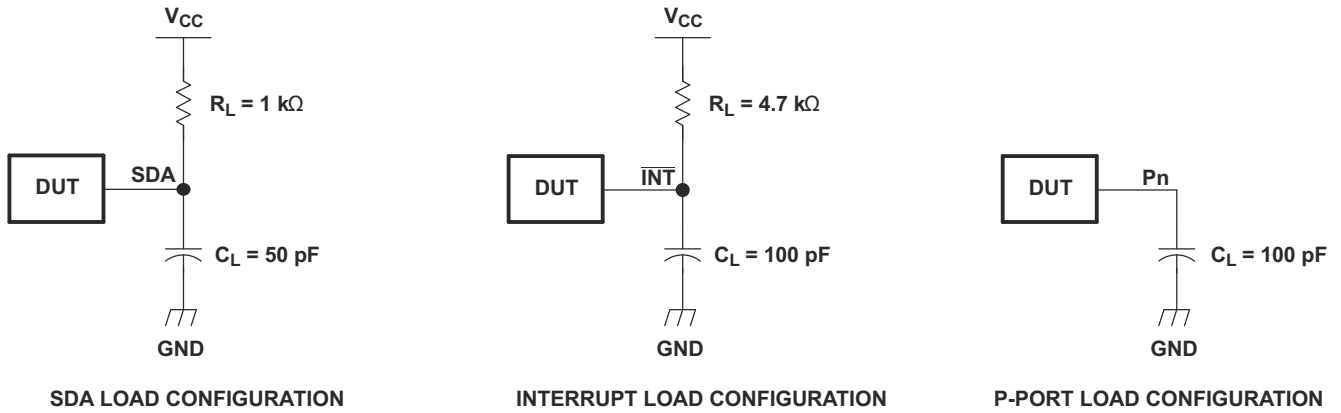
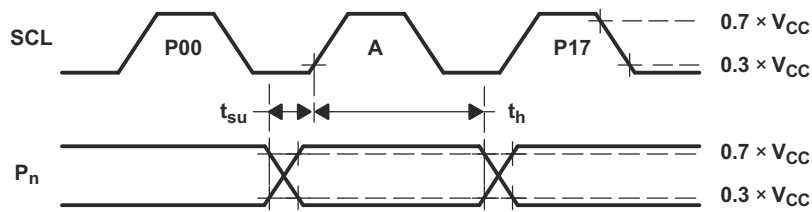


图 7-2. Interrupt Load Circuit and Voltage Waveforms



Write-Mode Timing (R/W = 0)



Read-Mode Timing (R/W = 1)

図 7-3. P-Port Load Circuits and Voltage Waveforms

## 8 Detailed Description

### 8.1 Overview

The PCF8575 provides general-purpose remote I/O expansion for most microcontroller families via the I<sup>2</sup>C interface serial clock (SCL) and serial data (SDA).

The device features a 16-bit quasi-bidirectional input/output (I/O) port (P07–P00, P17–P10), including latched outputs with high-current drive capability for directly driving LEDs. Each quasi-bidirectional I/O can be used as an input or output without the use of a data-direction control signal. At power on, the I/Os are high. In this mode, only a current source ( $I_{OH}$ ) to  $V_{CC}$  is active. An additional strong pullup to  $V_{CC}$  ( $I_{OHT}$ ) allows fast-rising edges into heavily loaded outputs. This device turns on when an output is written high and is switched off by the negative edge of SCL. The I/Os should be high before being used as inputs. After power on, as all the I/Os are set high, all of them can be used as inputs. Any change in setting of the I/Os as either input or outputs can be done with the write mode. If a high is applied externally to an I/O that has been written earlier to low, a large current ( $I_{OL}$ ) will flow to GND.

The PCF8575 provides an open-drain interrupt ( $\overline{INT}$ ) output, which can be connected to the interrupt input of a microcontroller. An interrupt is generated by any rising or falling edge of the port inputs in the input mode. After time,  $t_{iv}$ , the signal  $\overline{INT}$  is valid. Resetting and reactivating the interrupt circuit is achieved when data on the port is changed to the original setting, or data is read from or written to the port that generated the interrupt. Resetting occurs in the read mode at the acknowledge (ACK) bit after the rising edge of the SCL signal or in the write mode at the ACK bit after the falling edge of the SCL signal. Interrupts that occur during the ACK clock pulse can be lost (or be very short), due to the resetting of the interrupt during this pulse. Each change of the I/Os after resetting is detected and is transmitted as  $\overline{INT}$ . Reading from or writing to another device does not affect the interrupt circuit. This device does not have internal configuration or status registers. Instead, read or write to the device I/Os directly after sending the device address (see [Figure 8-6](#) and [Figure 8-7](#)).

By sending an interrupt signal on this line, the remote I/O can inform the microcontroller if there is incoming data on its ports, without having to communicate via the I<sup>2</sup>C bus. Thus, the PCF8575 can remain a simple target device.

Every data transmission to or from the PCF8575 must consist of an even number of bytes. The first data byte in every pair refers to port 0 (P07–P00), and the second data byte in every pair refers to port 1 (P17–P10). To write to the ports (output mode), the controller first addresses the target device, setting the last bit of the byte containing the target address to logic 0. The PCF8575 acknowledges, and the controller sends the first data byte for P07–P00. After the first data byte is acknowledged by the PCF8575, the second data byte (P17–P10) is sent by the controller. Once again, the PCF8575 acknowledges the receipt of the data, after which this 16-bit data is presented on the port lines.

The number of data bytes that can be sent successively is not limited. After every two bytes, the previous data is overwritten. When the PCF8575 receives the pairs of data bytes, the first byte is referred to as P07–P00 and the second byte as P17–P10. The third byte is referred to as P07–P00, the fourth byte as P17–P10, and so on.

Before reading from the PCF8575, all ports desired as input should be set to logic 1. To read from the ports (input mode), the controller first addresses the target device, setting the last bit of the byte containing the target address to logic 1. The data bytes that follow on the SDA are the values on the ports. If the data on the input port changes faster than the controller can read, this data may be lost.

When power is applied to  $V_{CC}$ , an internal power-on reset holds the PCF8575 in a reset state until  $V_{CC}$  has reached  $V_{POR}$ . At that time, the reset condition is released, and the device I<sup>2</sup>C-bus state machine initializes the bus to its default state.

The hardware pins (A0, A1, and A2) are used to program and vary the fixed I<sup>2</sup>C address and allow up to eight devices to share the same I<sup>2</sup>C bus or SMBus. The fixed I<sup>2</sup>C address of the PCF8575 is the same as the PCF8575C, PCF8574, PCA9535, and PCA9555, allowing up to eight of these devices, in any combination, to share the same I<sup>2</sup>C bus or SMBus.

## 8.2 Functional Block Diagram

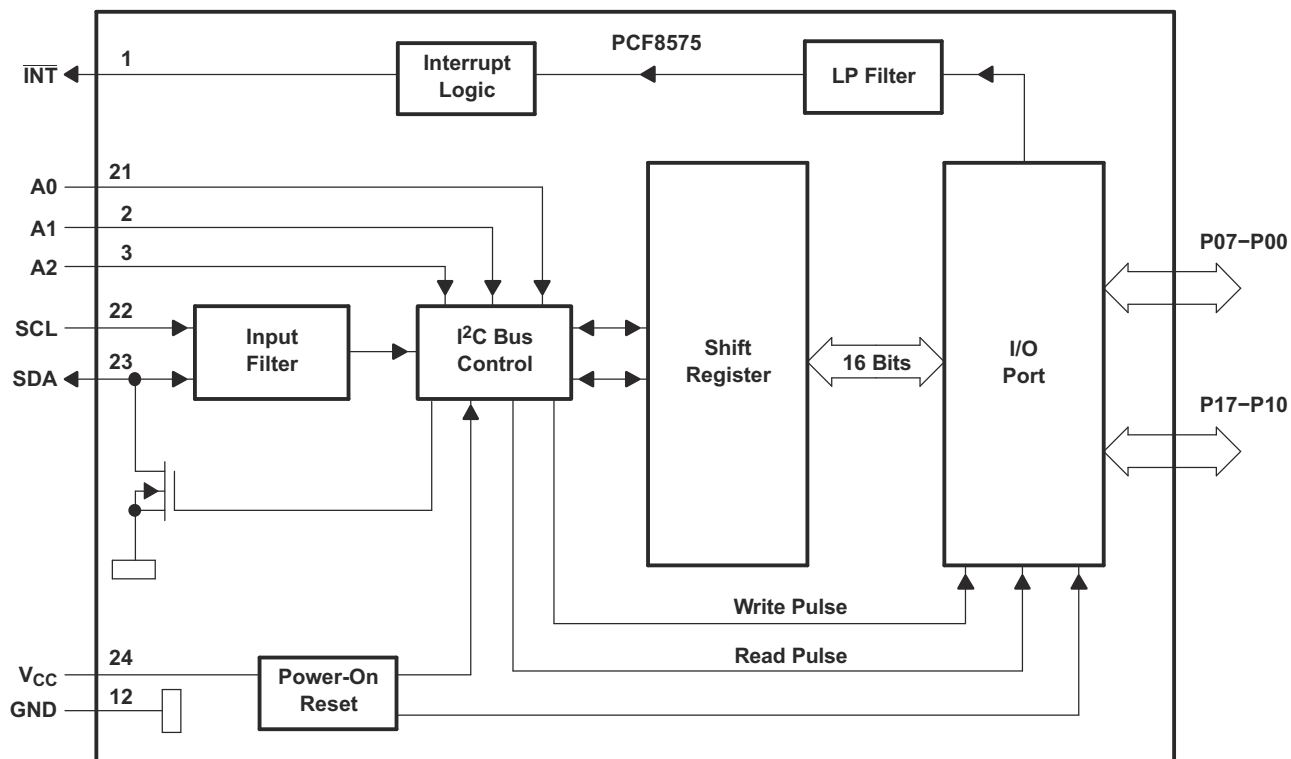


図 8-1. Logic Diagram (Positive Logic)

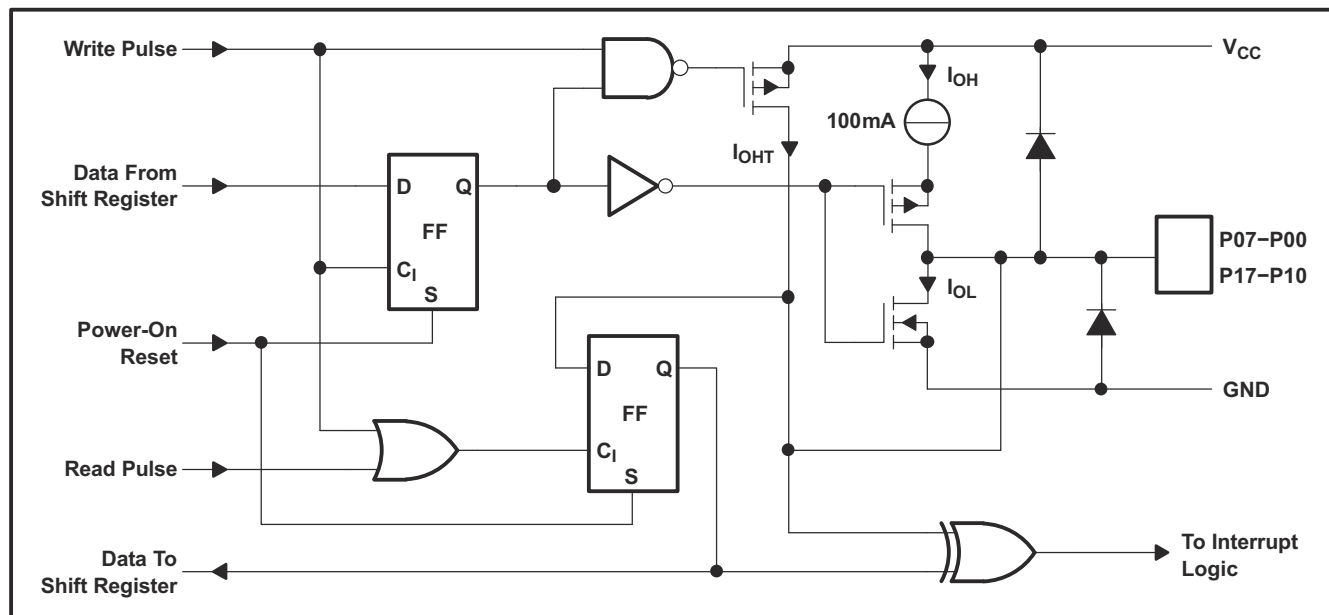


図 8-2. Simplified Schematic Diagram of Each P-Port Input or Output

## 8.3 Feature Description

### 8.3.1 I<sup>2</sup>C Interface

The bidirectional I<sup>2</sup>C bus consists of the serial clock (SCL) and serial data (SDA) lines. Both lines must be connected to a positive supply via a pullup resistor when connected to the output stages of a device. Data transfer may be initiated only when the bus is not busy.

I<sup>2</sup>C communication with this device is initiated by a controller sending a Start condition, a high-to-low transition on the SDA input/output while the SCL input is high (see [Figure 8-3](#)). After the Start condition, the device address byte is sent, most significant bit (MSB) first, including the data direction bit (R/  $\bar{W}$ ). This device does not respond to the general call address. After receiving the valid address byte, this device responds with an ACK, a low on the SDA input/output during the high of the ACK-related clock pulse. The address inputs (A2–A0) of the target device must not be changed between the Start and Stop conditions.

The data byte follows the address ACK. If the R/  $\bar{W}$  bit is high, the data from this device are the values read from the P port. If the R/  $\bar{W}$  bit is low, the data are from the controller, to be output to the P port. The data byte is followed by an ACK sent from this device. If other data bytes are sent from the controller, following the ACK, they are ignored by this device. Data are output only if complete bytes are received and acknowledged. The output data is valid at time ( $t_{pv}$ ) after the low-to-high transition of SCL, during the clock cycle for the ACK.

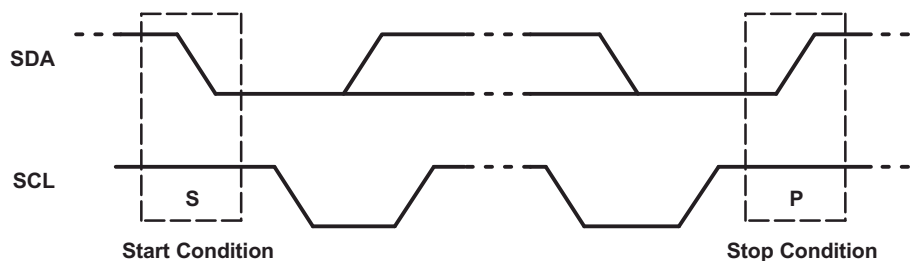
On the I<sup>2</sup>C bus, only one data bit is transferred during each clock pulse. The data on the SDA line must remain stable during the high pulse of the clock period, as changes in the data line at this time are interpreted as control commands (Start or Stop) (see [Figure 8-4](#)).

A Stop condition, a low-to-high transition on the SDA input/output while the SCL input is high, is sent by the controller (see [Figure 8-3](#)).

The number of data bytes transferred between the Start and Stop conditions from transmitter to receiver is not limited. Each byte of eight bits is followed by one ACK bit. The transmitter must release the SDA line before the receiver can send an ACK bit.

A target receiver that is addressed must generate an ACK after the reception of each byte. Also, a controller must generate an ACK after the reception of each byte that has been clocked out of the target transmitter. The device that acknowledges has to pull down the SDA line during the ACK clock pulse so that the SDA line is stable low during the high pulse of the ACK-related clock period (see [Figure 8-5](#)). Setup and hold times must be taken into account.

A controller receiver must signal an end of data to the transmitter by not generating an acknowledge (NACK) after the last byte that has been clocked out of the target. This is done by the controller receiver by holding the SDA line high. In this event, the transmitter must release the data line to enable the controller to generate a Stop condition.



**Figure 8-3. Definition of Start and Stop Conditions**

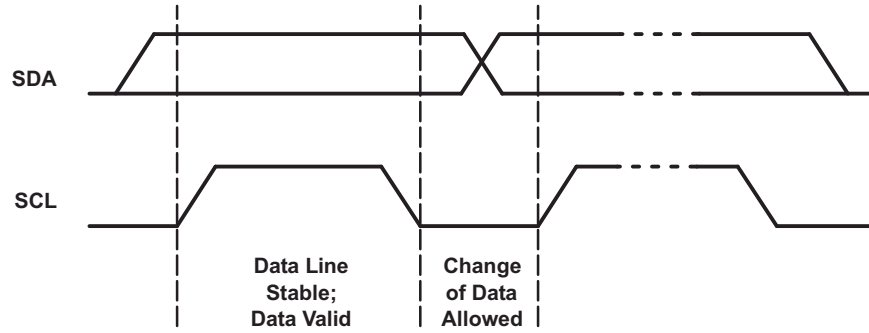


図 8-4. Bit Transfer

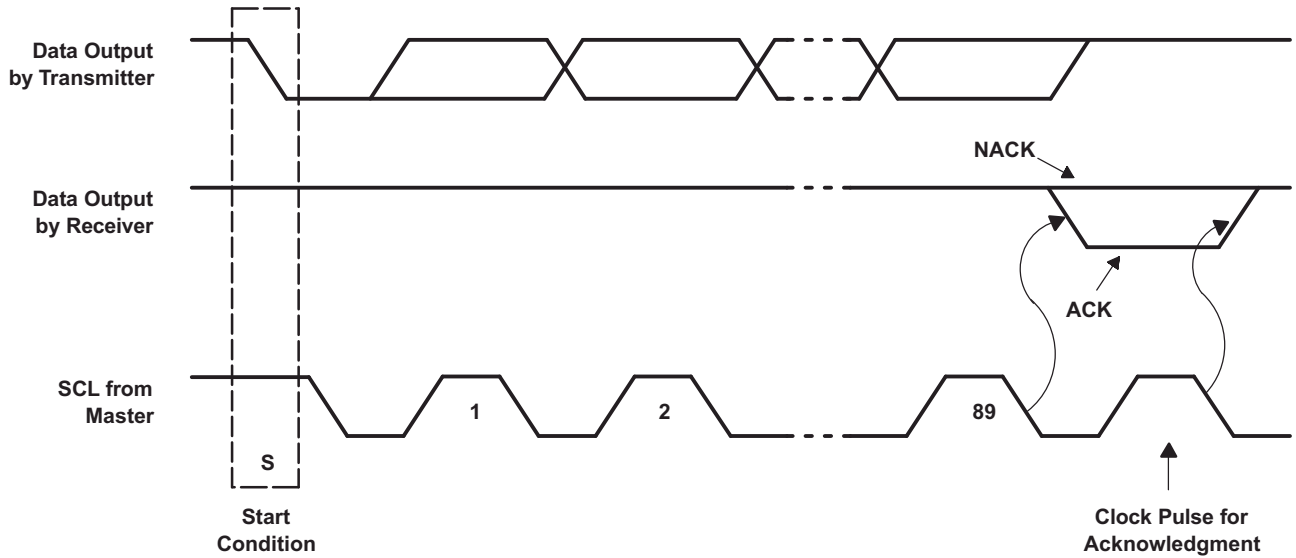


図 8-5. Acknowledgment on I<sup>2</sup>C Bus

### 8.3.2 Interface Definition

BYTE	BIT							
	7 (MSB)	6	5	4	3	2	1	0 (LSB)
I <sup>2</sup> C target address	L	H	L	L	A2	A1	A0	R/ W
P0x I/O data bus	P07	P06	P05	P04	P03	P02	P01	P00
P1x I/O data bus	P17	P16	P15	P14	P13	P12	P11	P10

### 8.3.3 Address Reference

INPUTS			I <sup>2</sup> C BUS TARGET 8-BIT READ ADDRESS	I <sup>2</sup> C BUS TARGET 8-BIT WRITE ADDRESS
A2	A1	A0		
L	L	L	65 (decimal), 41 (hexadecimal)	64 (decimal), 40 (hexadecimal)
L	L	H	67 (decimal), 43 (hexadecimal)	66 (decimal), 42 (hexadecimal)
L	H	L	69 (decimal), 45 (hexadecimal)	68 (decimal), 44 (hexadecimal)
L	H	H	71 (decimal), 47 (hexadecimal)	70 (decimal), 46 (hexadecimal)
H	L	L	73 (decimal), 49 (hexadecimal)	72 (decimal), 48 (hexadecimal)
H	L	H	75 (decimal), 4B (hexadecimal)	74 (decimal), 4A (hexadecimal)
H	H	L	77 (decimal), 4D (hexadecimal)	76 (decimal), 4C (hexadecimal)
H	H	H	79 (decimal), 4F (hexadecimal)	78 (decimal), 4E (hexadecimal)

### 8.4 Device Functional Modes

Figure 8-6 and Figure 8-7 show the address and timing diagrams for the write and read modes, respectively.

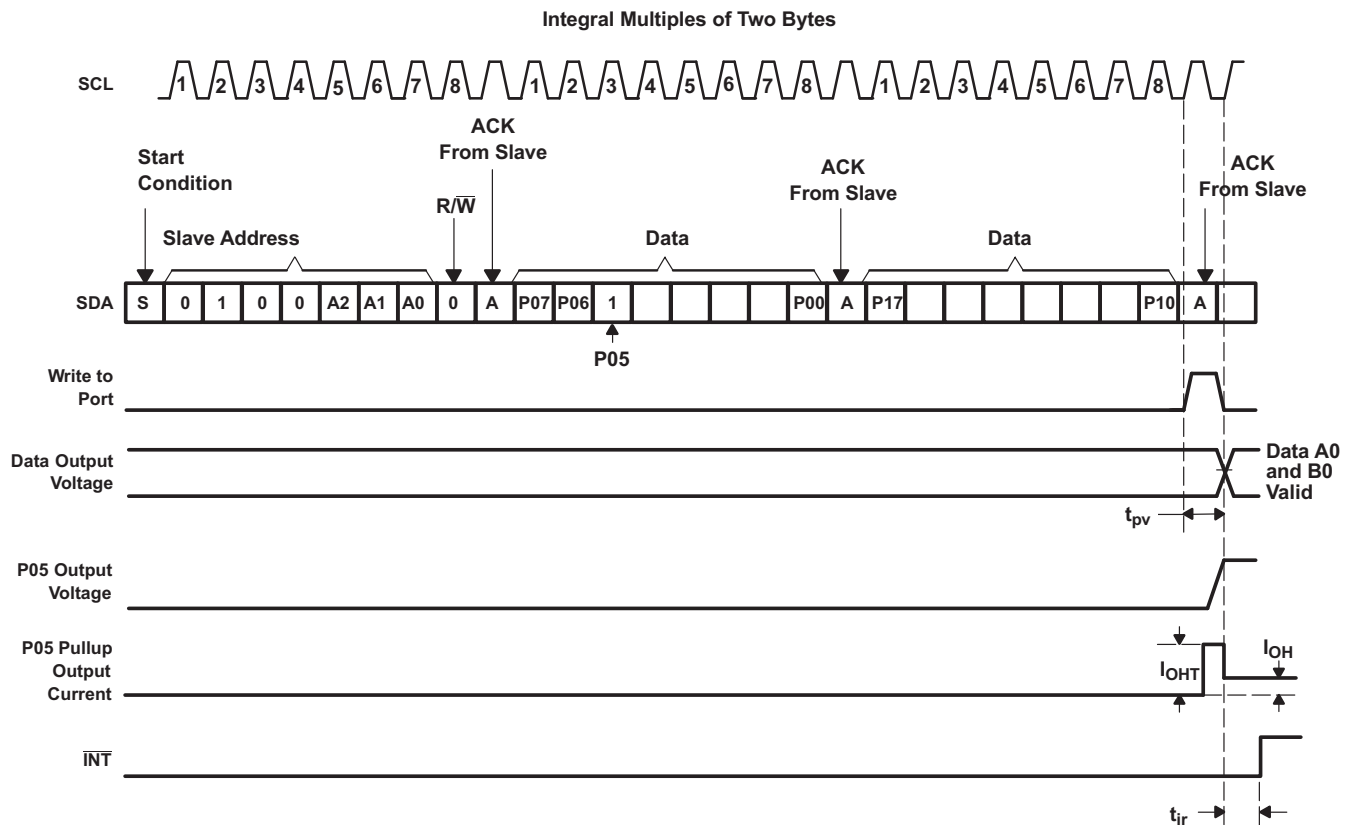
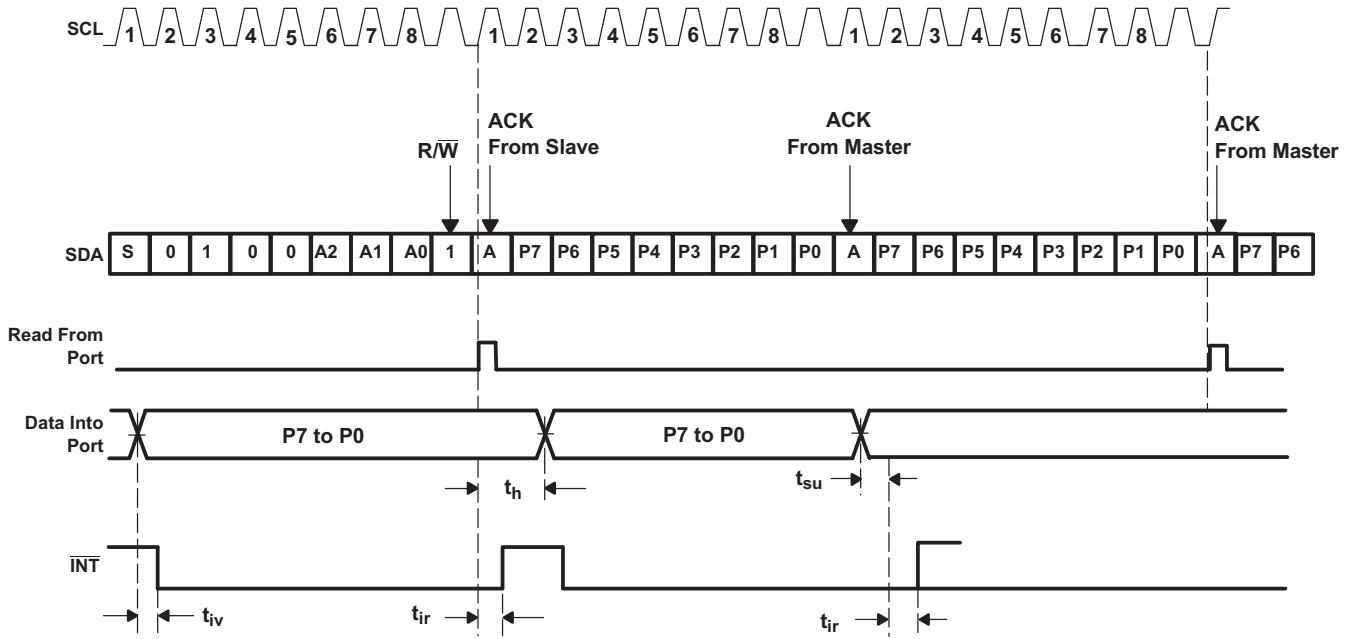


Figure 8-6. Write Mode (Output)





 **8-7. Read Mode (Input)**

## 9 Application and Implementation

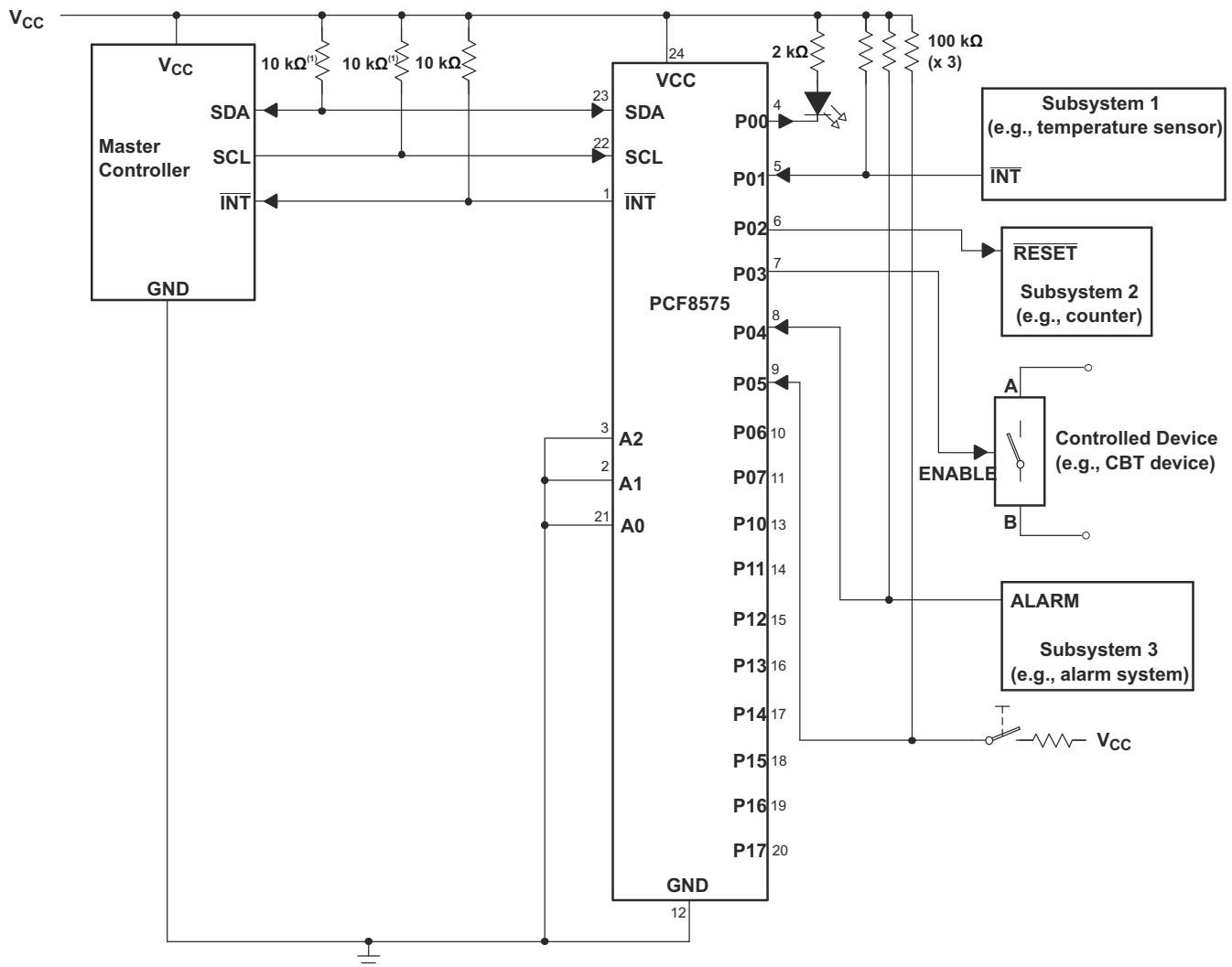
### 注

以下のアプリケーション情報は、TI の製品仕様に含まれるものではなく、TI ではその正確性または完全性を保証いたしません。個々の目的に対する製品の適合性については、お客様の責任で判断していただくこととなります。お客様は自身の設計実装を検証しテストすることで、システムの機能を確認する必要があります。

### 9.1 Application Information

図 9-1 shows an application in which PCF8575 can be used.

### 9.2 Typical Application



- The SCL and SDA pins must be tied directly to VCC because if SCL and SDA are tied to an auxiliary power supply that could be powered on while VCC is powered off, then the supply current,  $I_{CC}$ , will increase as a result.
- Device address is configured as 0100000 for this example.
- P0, P2, and P3 are configured as outputs.
- P1, P4, and P5 are configured as inputs.
- P6 and P7 are not used and must be configured as outputs.

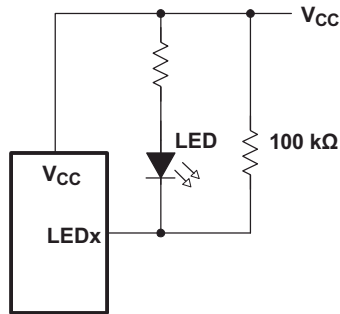
図 9-1. Application Schematic

## 9.2.1 Design Requirements

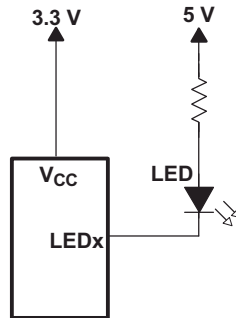
### 9.2.1.1 Minimizing $I_{CC}$ When I/Os Control LEDs

When the I/Os are used to control LEDs, normally they are connected to  $V_{CC}$  through a resistor as shown in [Figure 9-1](#). For a P-port configured as an input,  $I_{CC}$  increases as  $V_I$  becomes lower than  $V_{CC}$ . The LED is a diode, with threshold voltage  $V_T$ , and when a P-port is configured as an input the LED will be off but  $V_I$  is a  $V_T$  drop below  $V_{CC}$ .

For battery-powered applications, it is essential that the voltage of P-ports controlling LEDs is greater than or equal to  $V_{CC}$  when the P-ports are configured as input to minimize current consumption. [Figure 9-2](#) shows a high-value resistor in parallel with the LED. [Figure 9-3](#) shows  $V_{CC}$  less than the LED supply voltage by at least  $V_T$ . Both of these methods maintain the I/O  $V_I$  at or above  $V_{CC}$  and prevents additional supply current consumption when the P-port is configured as an input and the LED is off.



**Figure 9-2. High-Value Resistor in Parallel With LED**



**Figure 9-3. Device Supplied by a Lower Voltage**

### 9.2.2 Detailed Design Procedure

The pull-up resistors,  $R_p$ , for the SCL and SDA lines need to be selected appropriately and take into consideration the total capacitance of all targets on the I<sup>2</sup>C bus. The minimum pull-up resistance is a function of  $V_{CC}$ ,  $V_{OL(max)}$ , and  $I_{OL}$ :

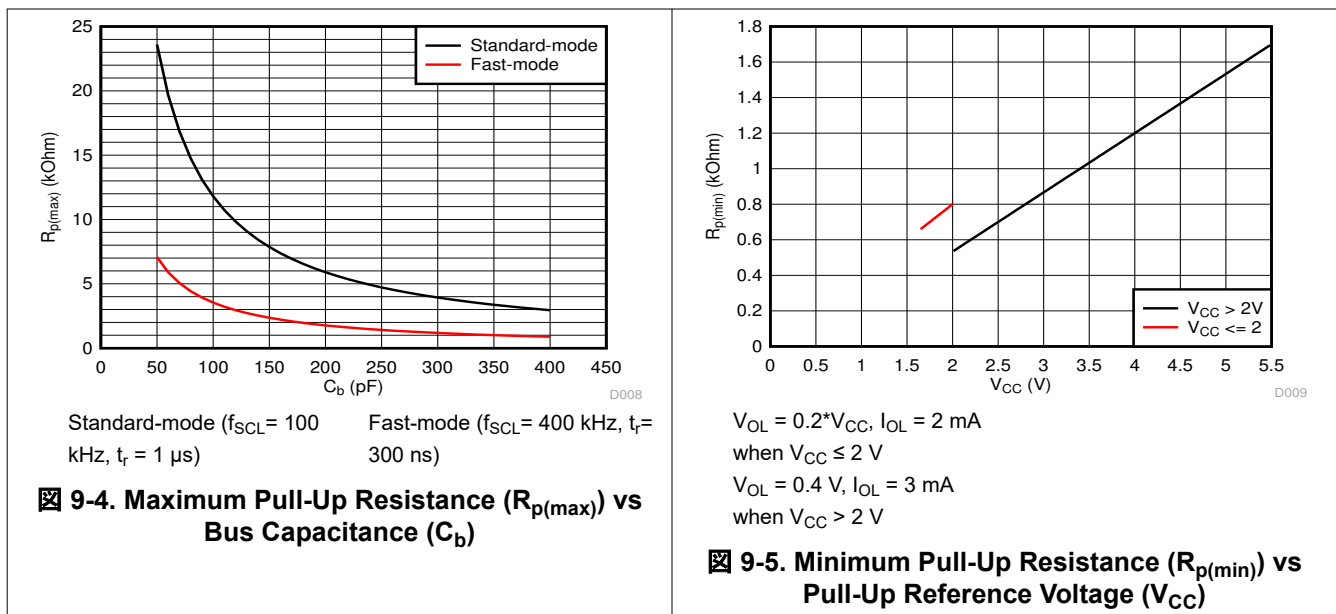
$$R_{p(min)} = \frac{V_{CC} - V_{OL(max)}}{I_{OL}} \quad (1)$$

The maximum pull-up resistance is a function of the maximum rise time,  $t_r$  (300 ns for fast-mode operation,  $f_{SCL} = 400$  kHz) and bus capacitance,  $C_b$ :

$$R_{p(max)} = \frac{t_r}{0.8473 \times C_b} \quad (2)$$

The maximum bus capacitance for an I<sup>2</sup>C bus must not exceed 400 pF for standard-mode or fast-mode operation. The bus capacitance can be approximated by adding the capacitance of the PCF8575,  $C_i$  for SCL or  $C_{io}$  for SDA, the capacitance of wires/connections/traces, and the capacitance of additional targets on the bus.

### 9.2.3 Application Curves

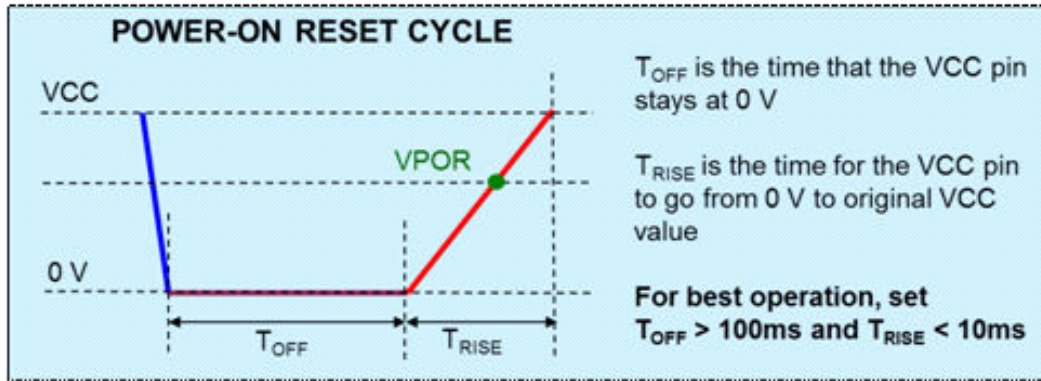


## 9.3 Power Supply Recommendations

The operating power-supply voltage range of the PCF8575 is 2.5 V to 5.5 V applied at the VCC pin. When the PCF8575 is powered on for the first time or anytime the device needs to be reset by cycling the power supply, the power-on reset requirements must be followed to ensure the I<sup>2</sup>C bus logic is initialized properly.

### 9.3.1 Power-On Reset

A power-on reset condition can be missed if the VCC ramps are outside specification listed below.



### 9.3.2 System Impact

If ramp conditions are outside timing allowances above, POR condition can be missed, causing the device to lock up.

## 9.4 Layout

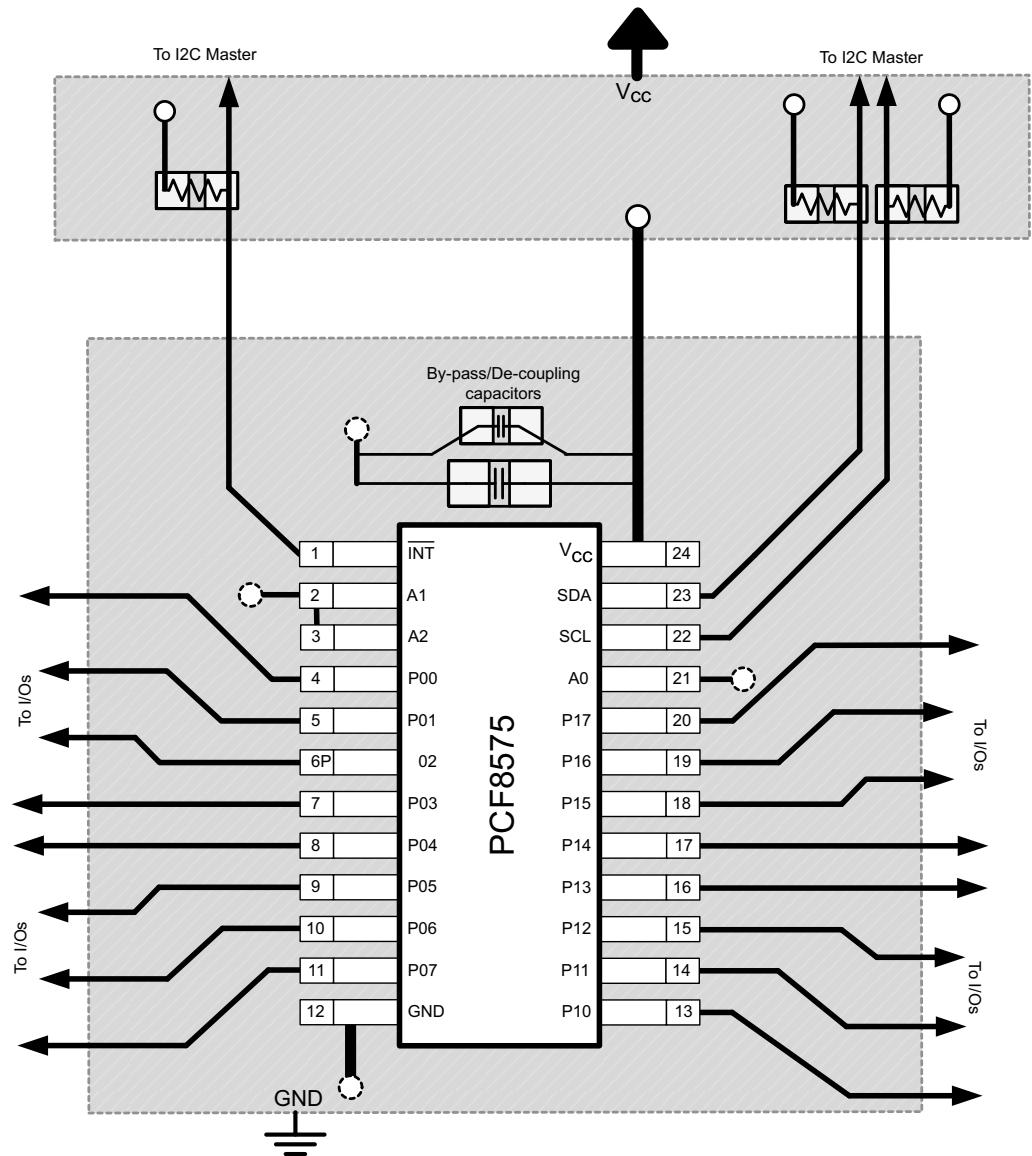
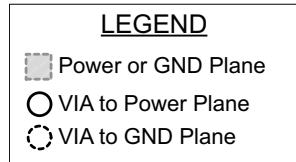
### 9.4.1 Layout Guidelines

For printed circuit board (PCB) layout of the PCF8575 device, common PCB layout practices should be followed but additional concerns related to high-speed data transfer such as matched impedances and differential pairs are not a concern for I<sup>2</sup>C signal speeds.

In all PCB layouts, it is a best practice to avoid right angles in signal traces, to fan out signal traces away from each other upon leaving the vicinity of an integrated circuit (IC), and to use thicker trace widths to carry higher amounts of current that commonly pass through power and ground traces. By-pass and de-coupling capacitors are commonly used to control the voltage on the V<sub>CC</sub> pin, using a larger capacitor to provide additional power in the event of a short power supply glitch and a smaller capacitor to filter out high-frequency ripple. These capacitors should be placed as close to the PCF8575 as possible. These best practices are shown in [Figure 9-6](#).

For the layout example provided in [Figure 9-6](#), it would be possible to fabricate a PCB with only 2 layers by using the top layer for signal routing and the bottom layer as a split plane for power (V<sub>CC</sub>) and ground (GND). However, a 4 layer board is preferable for boards with higher density signal routing. On a 4 layer PCB, it is common to route signals on the top and bottom layer, dedicate one internal layer to a ground plane, and dedicate the other internal layer to a power plane. In a board layout using planes or split planes for power and ground, vias are placed directly next to the surface mount component pad which needs to attach to V<sub>CC</sub> or GND and the via is connected electrically to the internal layer or the other side of the board. Vias are also used when a signal trace needs to be routed to the opposite side of the board, but this technique is not demonstrated in [Figure 9-6](#).

### 9.4.2 Layout Example



☒ 9-6. Layout Example for PCF8575

## 10 Device and Documentation Support

### 10.1 Device Support

### 10.2 Documentation Support

### 10.3 ドキュメントの更新通知を受け取る方法

ドキュメントの更新についての通知を受け取るには、[www.tij.co.jp](http://www.tij.co.jp) のデバイス製品フォルダを開いてください。[通知] をクリックして登録すると、変更されたすべての製品情報に関するダイジェストを毎週受け取ることができます。変更の詳細については、改訂されたドキュメントに含まれている改訂履歴をご覧ください。

### 10.4 サポート・リソース

テキサス・インスツルメンツ E2E™ サポート・フォーラムは、エンジニアが検証済みの回答と設計に関するヒントをエキスパートから迅速かつ直接得ることができる場所です。既存の回答を検索したり、独自の質問をしたりすることで、設計に必要な支援を迅速に得ることができます。

リンクされているコンテンツは、各寄稿者により「現状のまま」提供されるものです。これらはテキサス・インスツルメンツの仕様を構成するものではなく、必ずしもテキサス・インスツルメンツの見解を反映したものではありません。テキサス・インスツルメンツの[使用条件](#)を参照してください。

### 10.5 Trademarks

テキサス・インスツルメンツ E2E™ is a trademark of Texas Instruments.  
すべての商標は、それぞれの所有者に帰属します。

### 10.6 静電気放電に関する注意事項



この IC は、ESD によって破損する可能性があります。テキサス・インスツルメンツは、IC を取り扱う際には常に適切な注意を払うことを推奨します。正しい取り扱いおよび設置手順に従わない場合、デバイスを破損するおそれがあります。

ESD による破損は、わずかな性能低下からデバイスの完全な故障まで多岐にわたります。精密な IC の場合、パラメータがわずかに変化するだけで公表されている仕様から外れる可能性があるため、破損が発生しやすくなっています。


### 10.7 用語集

[テキサス・インスツルメンツ用語集](#) この用語集には、用語や略語の一覧および定義が記載されています。

## 11 Revision History

資料番号末尾の英字は改訂を表しています。その改訂履歴は英語版に準じています。

Changes from Revision H (February 2020) to Revision I (August 2024)	Page
• I <sup>2</sup> C に言及している場合、すべての旧式の用語をコントローラおよびターゲットに更新.....	1
• 「製品情報」表を「パッケージ情報」表に更新.....	1
• Updated Thermal Information.....	4
• Removed footnote #2 from Electrical Characteristics.....	5
• Updated I <sub>IHL</sub> test condition.....	5

Changes from Revision G (August 2018) to Revision H (February 2020)	Page
• Updated  8-6 .....	16

## 12 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

## 重要なお知らせと免責事項

テキサス・インスツルメンツは、技術データと信頼性データ (データシートを含みます)、設計リソース (リファレンス デザインを含みます)、アプリケーションや設計に関する各種アドバイス、Web ツール、安全性情報、その他のリソースを、欠陥が存在する可能性のある「現状のまま」提供しており、商品性および特定目的に対する適合性の黙示保証、第三者の知的財産権の非侵害保証を含むいかなる保証も、明示的または黙示的にかかわらず拒否します。

これらのリソースは、テキサス・インスツルメンツ製品を使用する設計の経験を積んだ開発者への提供を意図したものです。(1) お客様のアプリケーションに適した テキサス・インスツルメンツ製品の選定、(2) お客様のアプリケーションの設計、検証、試験、(3) お客様のアプリケーションに該当する各種規格や、その他のあらゆる安全性、セキュリティ、規制、または他の要件への確実な適合に関する責任を、お客様のみが単独で負うものとします。

上記の各種リソースは、予告なく変更される可能性があります。これらのリソースは、リソースで説明されている テキサス・インスツルメンツ製品を使用するアプリケーションの開発の目的でのみ、テキサス・インスツルメンツはその使用をお客様に許諾します。これらのリソースに関して、他の目的で複製することや掲載することは禁止されています。テキサス・インスツルメンツや第三者の知的財産権のライセンスが付与されている訳ではありません。お客様は、これらのリソースを自身で使用した結果発生するあらゆる申し立て、損害、費用、損失、責任について、テキサス・インスツルメンツおよびその代理人を完全に補償するものとし、テキサス・インスツルメンツは一切の責任を拒否します。

テキサス・インスツルメンツの製品は、[テキサス・インスツルメンツの販売条件](#)、または [ti.com](https://www.ti.com) やかかる テキサス・インスツルメンツ製品の関連資料などのいずれかを通じて提供する適用可能な条項の下で提供されています。テキサス・インスツルメンツがこれらのリソースを提供することは、適用されるテキサス・インスツルメンツの保証または他の保証の放棄の拡大や変更を意味するものではありません。

お客様がいかなる追加条項または代替条項を提案した場合でも、テキサス・インスツルメンツはそれらに異議を唱え、拒否します。

郵送先住所: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265

Copyright © 2024, Texas Instruments Incorporated



**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
PCF8575DBQR	ACTIVE	SSOP	DBQ	24	2500	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	PCF8575	<a href="#">Samples</a>
PCF8575DBR	ACTIVE	SSOP	DB	24	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	PF575	<a href="#">Samples</a>
PCF8575DGVR	ACTIVE	TVSOP	DGV	24	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	PF575	<a href="#">Samples</a>
PCF8575DW	OBSOLETE	SOIC	DW	24		TBD	Call TI	Call TI	-40 to 85	PCF8575	
PCF8575DWR	ACTIVE	SOIC	DW	24	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	PCF8575	<a href="#">Samples</a>
PCF8575PW	OBSOLETE	TSSOP	PW	24		TBD	Call TI	Call TI	-40 to 85	PF575	
PCF8575PWR	ACTIVE	TSSOP	PW	24	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	PF575	<a href="#">Samples</a>
PCF8575PWRE4	ACTIVE	TSSOP	PW	24	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	PF575	<a href="#">Samples</a>
PCF8575RGER	ACTIVE	VQFN	RGE	24	3000	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	PF575	<a href="#">Samples</a>

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

<sup>(6)</sup> Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

**Important Information and Disclaimer:**The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

## 重要なお知らせと免責事項

TI は、技術データと信頼性データ(データシートを含みます)、設計リソース(リファレンス・デザインを含みます)、アプリケーションや設計に関する各種アドバイス、Web ツール、安全性情報、その他のリソースを、欠陥が存在する可能性のある「現状のまま」提供しており、商品性および特定目的に対する適合性の黙示保証、第三者の知的財産権の非侵害保証を含むいかなる保証も、明示的または黙示的にかかわらず拒否します。

これらのリソースは、TI 製品を使用する設計の経験を積んだ開発者への提供を意図したものです。(1) お客様のアプリケーションに適した TI 製品の選定、(2) お客様のアプリケーションの設計、検証、試験、(3) お客様のアプリケーションに該当する各種規格や、その他のあらゆる安全性、セキュリティ、規制、または他の要件への確実な適合に関する責任を、お客様のみが単独で負うものとし、

上記の各種リソースは、予告なく変更される可能性があります。これらのリソースは、リソースで説明されている TI 製品を使用するアプリケーションの開発の目的でのみ、TI はその使用をお客様に許諾します。これらのリソースに関して、他の目的で複製することや掲載することは禁止されています。TI や第三者の知的財産権のライセンスが付与されている訳ではありません。お客様は、これらのリソースを自身で使用した結果発生するあらゆる申し立て、損害、費用、損失、責任について、TI およびその代理人を完全に補償するものとし、TI は一切の責任を拒否します。

TI の製品は、[TI の販売条件](#)、または [ti.com](#) やかかる TI 製品の関連資料などのいずれかを通じて提供する適用可能な条項の下で提供されています。TI がこれらのリソースを提供することは、適用される TI の保証または他の保証の放棄の拡大や変更を意味するものではありません。

お客様がいかなる追加条項または代替条項を提案した場合でも、TI はそれらに異議を唱え、拒否します。

郵送先住所 : Texas Instruments, Post Office Box 655303, Dallas, Texas 75265  
Copyright © 2024, Texas Instruments Incorporated